Hydrogeological and microbial controls on the isotope and molecular composition of coal seam gases and production waters of the Walloon Subgroup; Surat Basin, Australia

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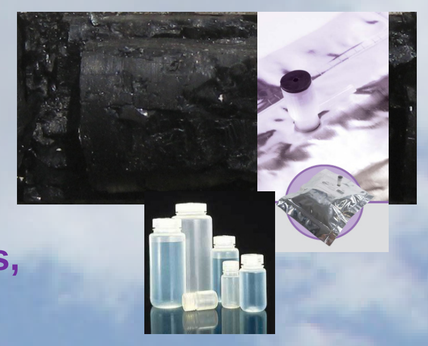


INTRODUCTION

Detailed geochemical studies of Walloon Subgroup waters and associated coal bed gases are essential for understanding: Gas generation, groundwater evolution, recharge, flow paths, and general aquifer behaviour.

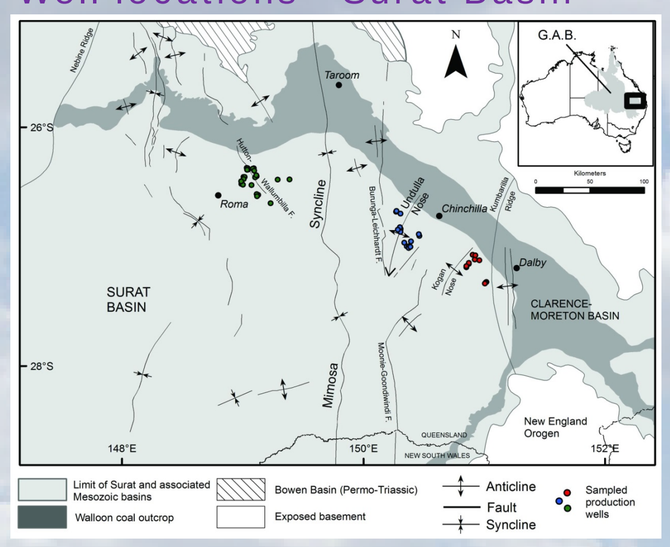
AIMS

1 Investigate the geochemical evolution of co-produced, Walloon coal bed waters and gases down groundwater flow-paths.

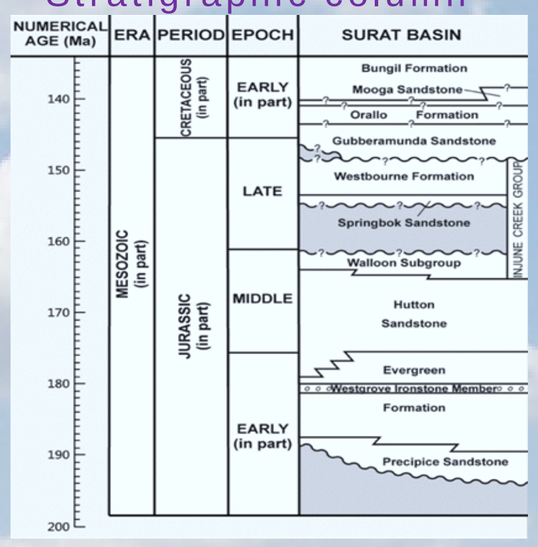
2 Test whether co-produced water compositional and stable isotopic data show relationships with gas-in-place and gas stable isotopes, to elucidate further evidence for microbial CO_2 reduction (cf. S.K. Hamilton et al., 2015, *Int. J. of Coal Geol., 138, 68-82)*.

3 Combine these data with age (^{14}C, ^{36}Cl) and tracer information, to constrain the timing of microbial methane generation.

Well locations – Surat Basin



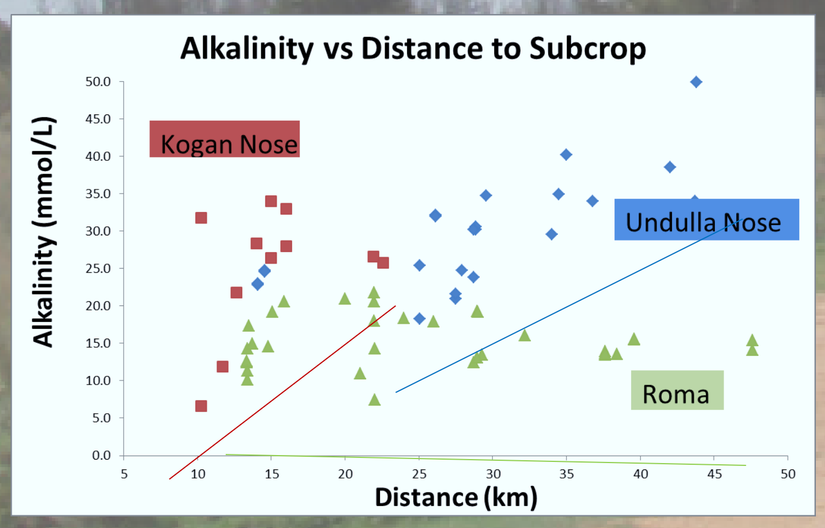
Stratigraphic column



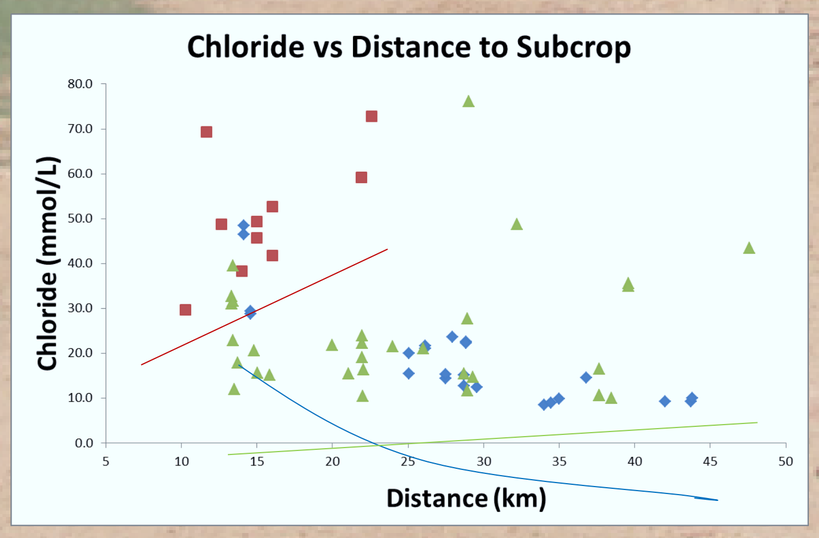
METHODS

- 52 CSG production wells across the three main production regions were sampled for water, gas and microbial communities (UQ Australian Centre for Ecogenomics, ACE), over a 6 year period (2009-2014).
- Geochemical analyses include: Standard water chemistry, stable and radiogenic isotopes, REEs and carbon and chloride dating.

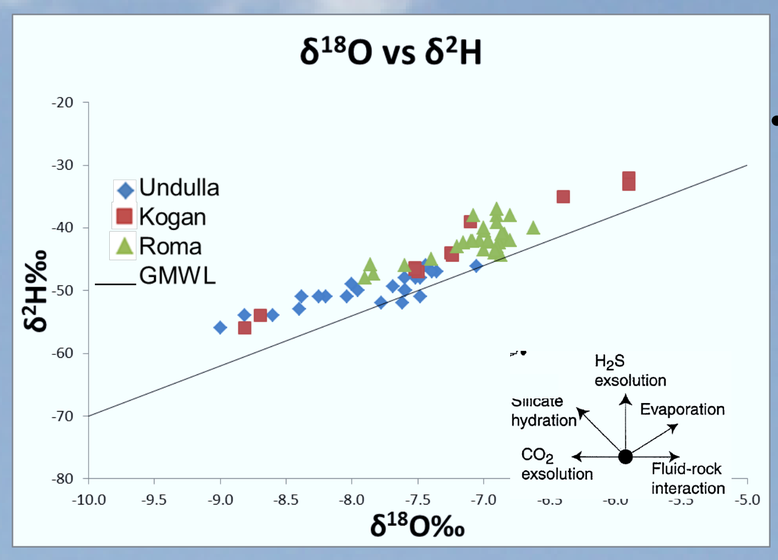
RESULTS



- Roma waters are the freshest,
- Kogan Nose waters most saline (based on median values).

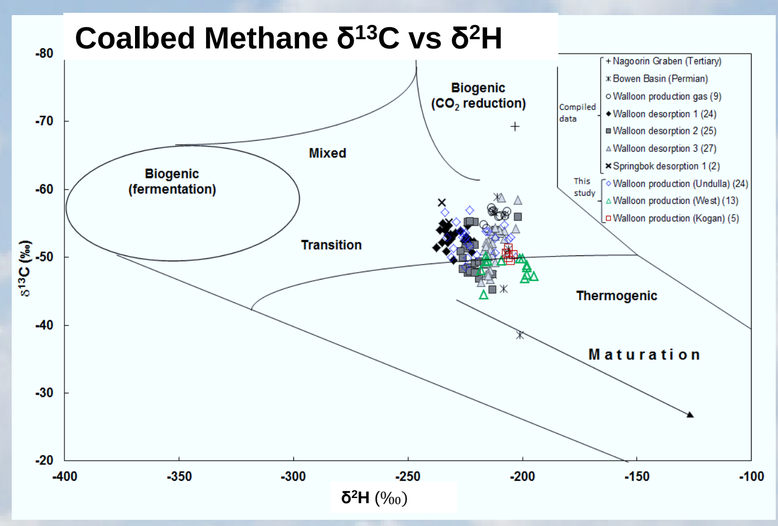


- Undulla waters do not follow expected trend of increasing Cl with distance from recharge zone.



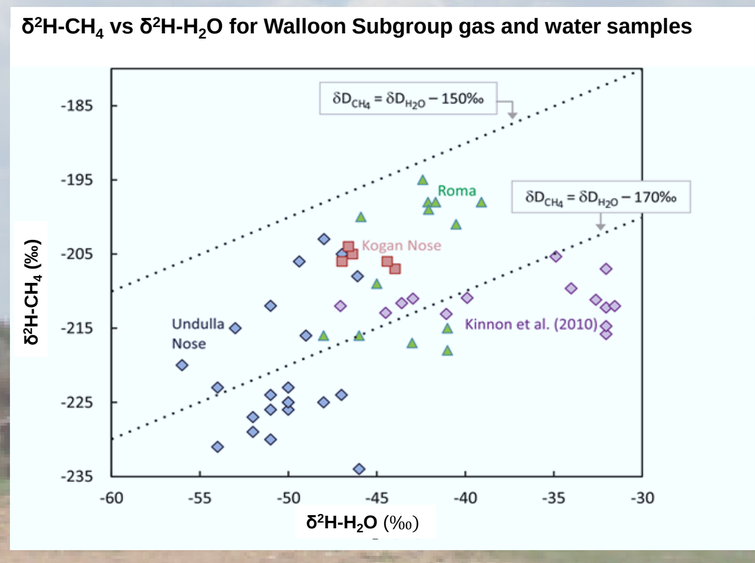
- Waters plot to left of global meteoric water line (GMWL), characteristic of methanogenesis.

- Undulla waters (O and H) become more positive with depth;
- Roma and Kogan waters (O and H) become more negative with depth.



- Walloon gases plot in the mixed to thermogenic zone.

- The calculated hydrogen isotopic difference range (dotted lines) between Walloon waters and methanes [$\Delta^2H(H_2O\text{-}CH_4)$].
- Supports CO_2 reduction and when coupled with age of waters suggests CH_4 generated since Late Pleistocene.



CONCLUSIONS

- **Water compositions geochemically distinct for each production region**
  - Different lithology of adjacent recharge zones
  - Extent of fluid-rock interactions
  - Different microbial consortia and extent of methanogenesis
- **Stable isotopic analysis of waters**
  - Atypical trend for Undulla Nose waters: Either more impacted by fluid-rock-microbial interactions OR faster groundwater infiltration rates
- **Stable isotopic analysis of gases**
  - Substrate depletion causes gases to plot in mixing zone rather than CO_2 reduction zone
  - Gases are microbial and formed via CO_2 reduction

SIGNIFICANCE

- (K.A. Baublys et al. 2015, *Int. J. Coal Geol.*, 147-148, 85-104) first integrated investigation of solute sources and microbial modifications to Walloon coal bed water chemistry at regional scale.